

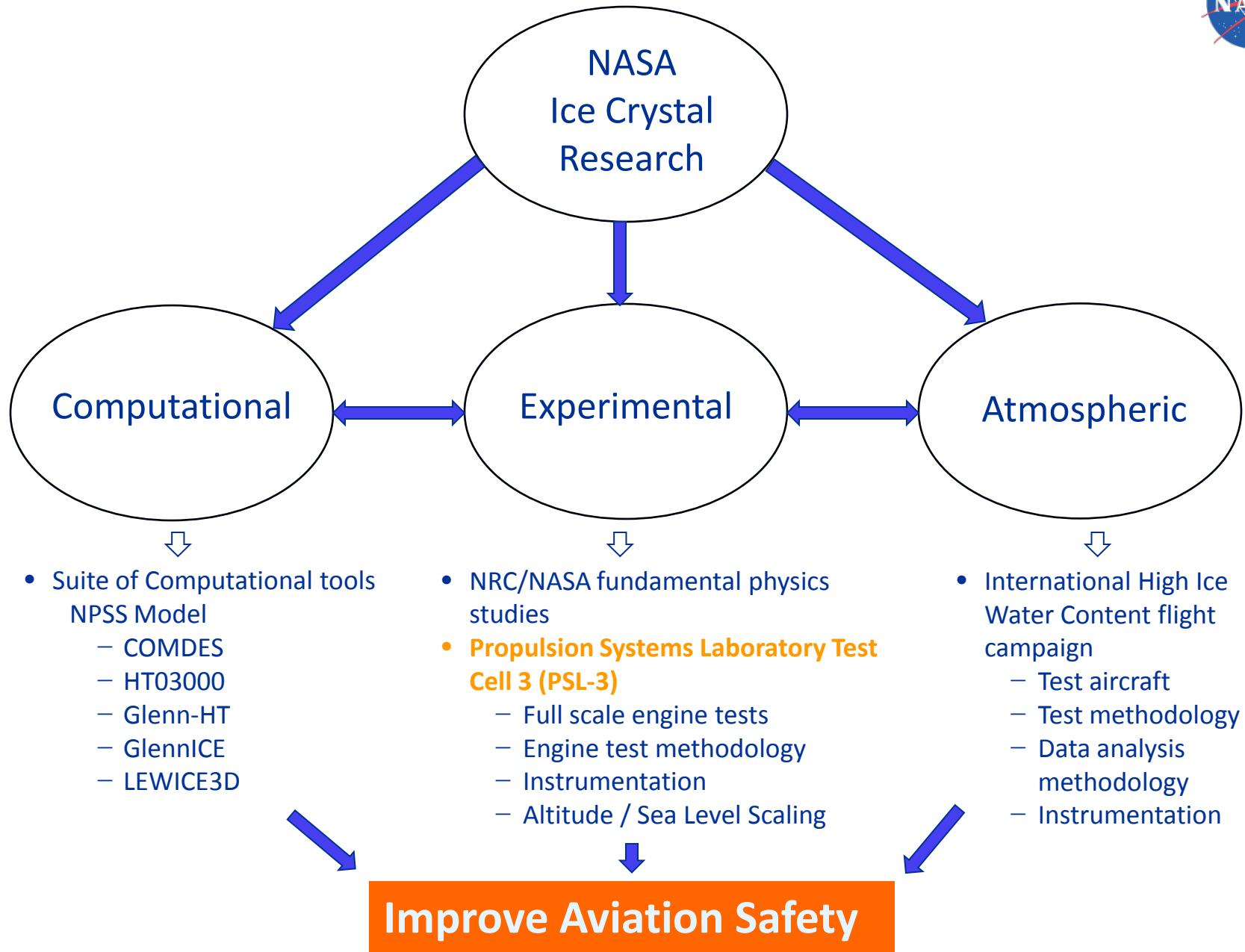
NASA GRC PSL-3 Technical Challenges

**Full Scale Engine Test Facility
Altitude and Sea Level Testing
in an Ice Crystal Environment**

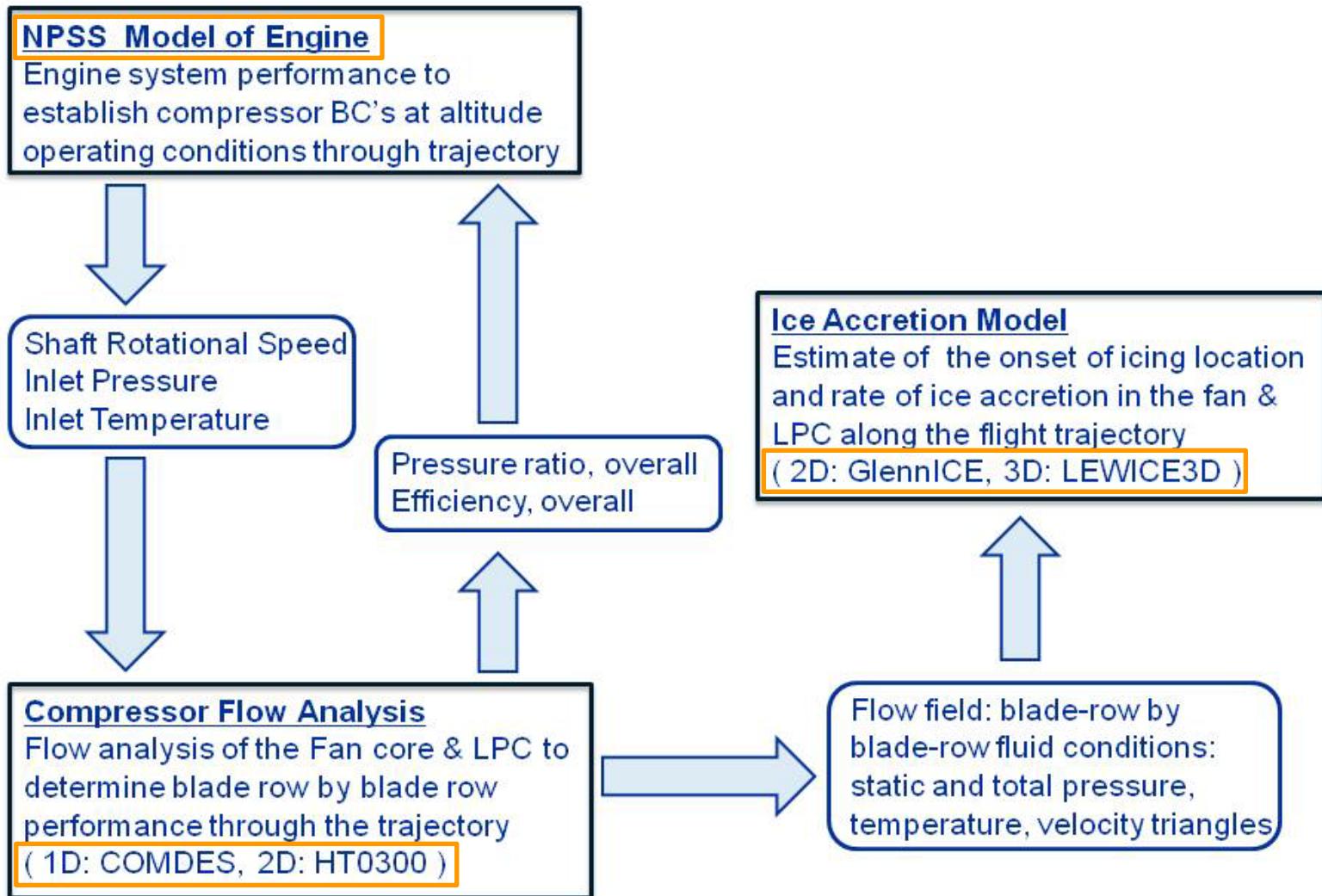
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Computational Research Diagram





Flight Campaign to Characterize HIWC Environment

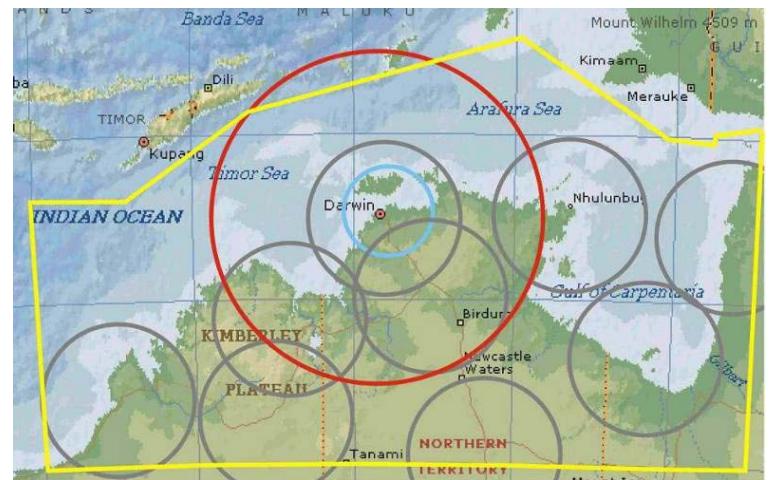
Objective: Obtain quantitative natural cloud information needed for research

Approach: Conduct flight campaigns in natural conditions

- Trial campaign to check instruments and methods (2012)
- Primary campaign to collect data (Jan 2013)

International Collaborative Effort:

NASA, FAA, Environment Canada, NRC-Canada, Transport Canada, Australian BOM, Boeing, NCAR, SEA, FTA, Airbus



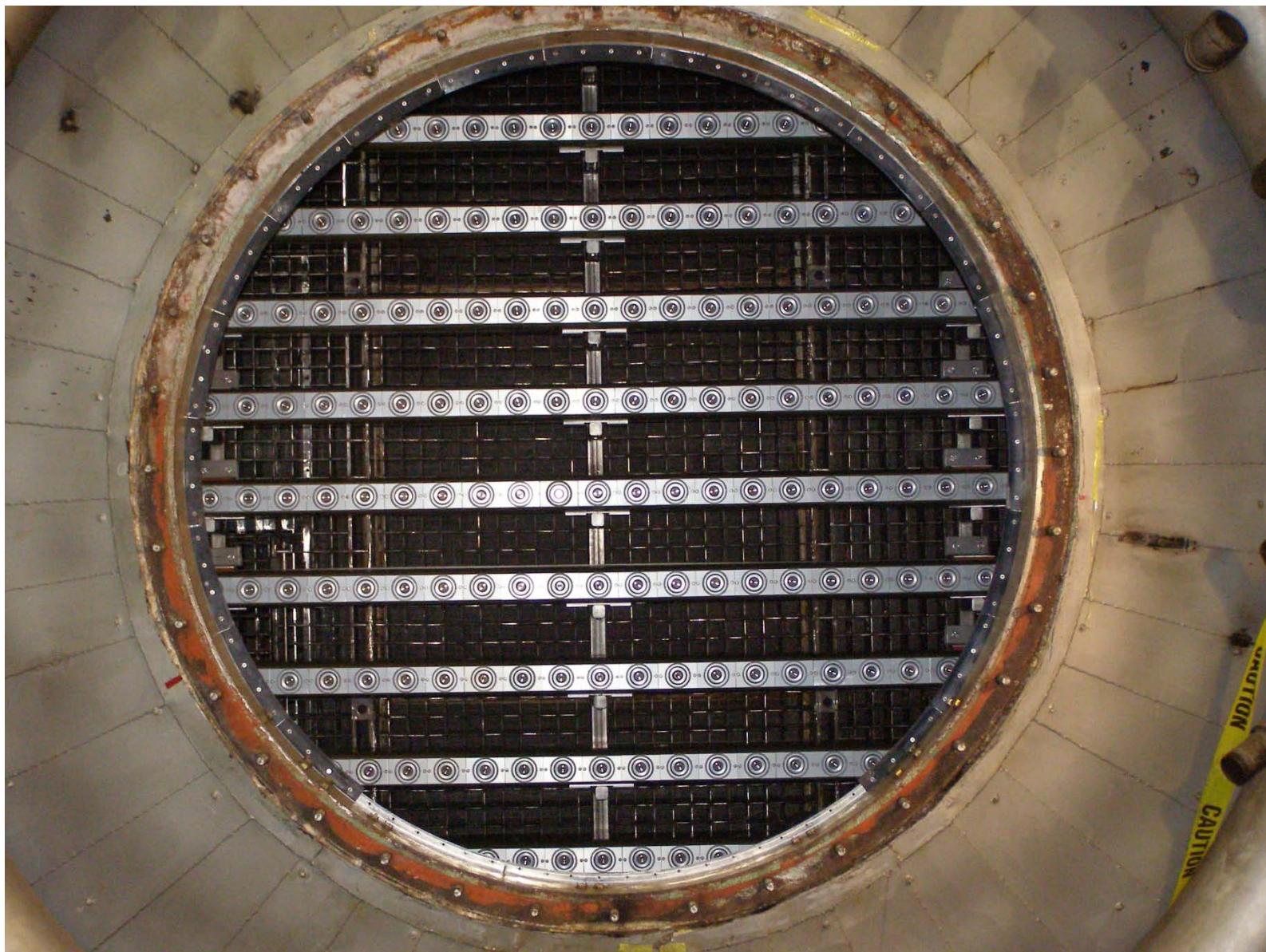
Propulsion Systems Laboratory Test Cell 3 (PSL-3)



PSL-3 Spraybars



PSL-3 Spraybars ALF View



Spraybar Details

Glycol System

- 50 Ton Chiller
- Feeds Cooling Air, Atomizing Air and Spray Water heat exchangers
- Condenser uses cooling tower water

Spray Water System

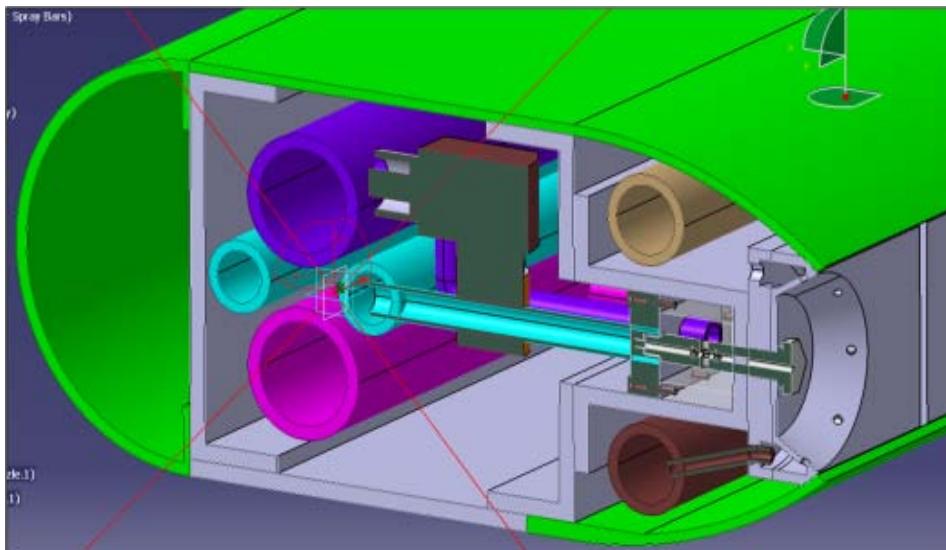
- Filtered city water
- Has re-circulating loop that includes holding tank, glycol heat exchanger, particle injection system, and boost pumps

Atomizing Air

- Supplied from 6" Shop Air header (100 psi)
- Glycol heat exchanger reduces temperature
- Control valves set required pressure

LN2 System

- 3,000 gal. Dewar, vacuum jacketed pipe, heat exchanger, flash tank and vent stack
- delivered to heat exchanger
- control valve used to modulate flow for desired set point on cooling air



Cooling Air

- Supplied from 6" Shop Air header (100 psi)
- Desiccant dried
- Cooled by glycol and LN2 heat exchangers
- Control valves set required pressure for spray bars

PSL-3 Capabilities



PSL-3 Capabilities

Propulsion System Laboratory	
Pressure Altitude (ft)	1,000 to 90,000
Min. Static Temperature (F)	-50
Max. Mass flow (lbm/sec)	330
Thrust Stand Capacities (lbf)	10k, 40k and 50k
Test Cell (ϕ ft x L ft)	24 x 39

Technical Challenges

Calibration

Control

Reliability

Instrumentation

Test Methodology

Altitude Scaling

PSL-3 Targeted Ice Crystal Capabilities

Propulsion System Laboratory Ice Crystal Capabilities	
Pressure Altitude (ft)	4,000 to 40,000
Min. Static Temperature (F)	-50
Max. Mass flow (lbm/sec)	330
Thrust Stand Capacities (lbf)	10k, 40k and 50k
Direct Connect Test Cell (ϕ ft)	3 ft
Ice Particle Size, MVD (microns)	40-60
Ice Water Content, IWC, (g/m ³)	0.5 to 9



PSL-3 Deliverables

1. Validated high altitude, ice crystal, full scale engine test facility
2. Research data to support NASA mission: *Improve Aviation Safety*
3. Altitude /ice crystal facility engine test techniques, practices and standards
4. Novel facility and engine instrumentation
5. Altitude Scaling Laws

PSL-3 Artist Rendering
-GVIS LAB NASA GRC et.al



Questions?

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